INSTRUCTION MANUAL

Single Channel Temperature Controller MODEL 012031

THERMOTRON

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GENERAL INFORMATION

This controller is designed to control temperature within a test environment. The controller provides an output (one) to achieve controlled temperature within a range of -125°F. to +375°F.

The controller output is coupled to a solid state relay. The solid state relay is a zero voltage firing device and allows a load to be energized with minimum RFI signals.

The sensor input is Type 'T' copper/constantan thermocouple wire. This sensor is a conventional butt-welded thermocouple. A sensor failure protection features causes the controller temperature signal to be driven to the maximum upscale value and the output to the OFF state.

With the SET POINT/TEMPERATURE switch in a SET POINT position, the pointer will indicate the temperature set point selected by a ten-turn potentiometer. In the TEMPERATURE position (spring return) the meter will monitor the test environment temperature.

Proportioning-like action and reset action can be added to the controller to achieve optimum system response.

SPECIFICATIONS

Input Sensor:
Thermocouple, Type 'T' copper/constantan.

Sensor Break/Failsafe Protection:
Circuit design drives temperature indication to maximum upscale value and puts controller output to the OFF state if T/C opens.

Control Range:
-125°F. to +375°F. (-90°C. to +190°C.).

Measuring Accuracy:
± 1% over operating temperature range.

Output:
Voltage drive for zero cross-over firing solid state power relay.

ON state:	+4.5 V dc to +9 V dc.
OFF state:	0 V dc to +.4 V dc.

Indication:
Precision analog meter (± 1% meter accuracy).

Set Point Provision:
10-Turn potentiometer.

Operating Temperature Range:
40°F. to 120°F.

Power Requirement:
115 Vac, 50/60 Hz. ± 10%. 10 Volt - amperes maximum.

CALIBRATION

Equipment Required:

1. Portable potentiometer:
   Type 'T' thermocouple calibration required.

2. Digital voltmeter:
   Use a digital voltmeter of 0.1% accuracy.

3. Thermocouple extension wire:
   Six (6) feet of Type 'T' thermocouple wire.

- WARNING -

Power is ON when working on the controller and can cause serious injury if accidentally touched. Also, be careful with tools and circuit testing methods. Solid state devices can be easily damaged if improper techniques or accidental shorting result while making circuit tests.

Procedure:

1. With power OFF:
   Make mechanical zero adjust (-125°F. on indicating meter) with zero adjust screw on meter front.

2. Connect portable potentiometer:
   Connect six (6) feet of Type 'T' thermocouple wire to controller T/C terminal TB1 (Ref: Dwg. I-2053B-2-X). The T/C red wire is negative and the blue wire is positive.

3. Connect power:
   Apply 115 V ac power to TB2, hot wire to L and neutral wire to N. Allow controller to warm up approximately 15 minutes before calibrating.

4. With the digital voltmeter, real voltage V1 and adjust potentiometer P1 for a (4.50) volt dc reading. (Ref: Dwg. I-2053B-2-X). Connect the positive (+) lead to V1 and the negative (-) lead to M-.

   NOTE: T/C input must be open when making voltage readings V1 and V2.

5. Measure voltage V2 and adjust potentiometer P6 for (15) millivolts dc. Connect the positive (+) lead to V2 and the negative (-) lead to M-.

6. Repeat Steps 4 and 5 to verify voltage readings.

7. Turn manual set potentiometer full CCW.

CALIBRATION (Continued)

8. Apply a -100°F. input signal with the portable potentiometer.

9. Adjust zero potentiometer P1 to align the pointer of the indication meter with the -100°F. scale position.

10. Apply a +350°F. input signal with the portable potentiometer.

11. Adjust span potentiometer P2 to align the pointer of the indication meter with the +350°F. scale potentiometer.

12. Repeat Steps 9 and 11 to verify meter indication.

13. Turn manual set potentiometer full CW.

14. Hold the SET POINT/TEMP indication switch in the SET POINT position and adjust potentiometer P3 to align the meter pointer with the +375°F.

15. Adjust "Amplitude" potentiometer P4 full CCW and adjust "Cycle" potentiometer P5 full CW. Further adjustments of potentiometers P4 and P5 are determined upon system operation.

    NOTE: Potentiometers P4 and P5 are adjusted to set the proportioning-like action of the controller. Potentiometer P4 sets the point at which the proportioning action starts. (Full CCW adjustment will bring proportioning action into play at the maximum deviation from set point.) Potentiometer P5 sets the delay before the controller turns ON. (Full CCW adjustment will set the maximum delay time.)

PERFORMANCE CHECKS

The following checks are minimum requirements for controller operation. The controller should operate properly if the minimum performance checks are found to be within limits.

However, if the control function does not seem to respond as it should, be sure to check other possible conditions that could impair system operations, such as improper T/C location, heater burn-out, open fuse link, improper function selection for system load, cooling system malfunction, etc.

Refer to Dwgs. I-2053B-1-X and I-2053B-2-X.

Input Power: 115 V ac, 50/60 Hz, ±10% (TB2, "L" to "N").

Unregulated B+: +18 V dc to +30 V dc (Measure "B+ unreg").

Regulated B+: +14.4 to +15.6 constant voltage (Measure "B+ reg").

Proper T/C Connection: Type 'T' copper/constantan. Blue (+), Red (-). (TB1 connections.)

Sensor Break/Failsafe Check: Remove T/C and note meter indication to drive upscale to maximum position.

Output Voltage:	ON State:	+4.5 V dc to +9 V dc.
	OFF State:	0 V dc to .4 V dc.

This check is made with the solid state relay properly connected and measured across solid state relay signal input terminals.

PROPER CALIBRATION:

Controller must be calibrated as outlined in "Calibration Procedure". Check controller calibration at least once every six (6) months.

COPPER vs. COPPER-NICKEL

(Copper-Constantan)

Temperature in Degrees F

Reference Junction at 32°F

THERMOELECTRIC VOLTAGE IN ABSOLUTE MILLIVOLTS

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEC F
-190	-4.009	-4.023	-4.037	-4.051	-4.065	-4.079	-4.093	-4.107	-4.121	-4.135	-4.149	-190
-180	-3.864	-3.879	-3.894	-3.908	-3.923	-3.937	-3.951	-3.966	-3.980	-3.994	-4.009	-180
-170	-3.717	-3.732	-3.746	-3.761	-3.776	-3.791	-3.806	-3.820	-3.835	-3.850	-3.864	-170
-160	-3.565	-3.580	-3.596	-3.611	-3.626	-3.641	-3.656	-3.671	-3.687	-3.702	-3.717	-160
-150	-3.410	-3.425	-3.441	-3.457	-3.472	-3.488	-3.503	-3.519	-3.534	-3.550	-3.565	-150
-140	-3.251	-3.267	-3.283	-3.299	-3.315	-3.331	-3.347	-3.362	-3.378	-3.394	-3.410	-140
-130	-3.089	-3.105	-3.121	-3.138	-3.154	-3.170	-3.186	-3.203	-3.219	-3.235	-3.251	-130
-120	-2.923	-2.939	-2.956	-2.973	-2.989	-3.006	-3.023	-3.039	-3.056	-3.072	-3.089	-120
-110	-2.753	-2.771	-2.788	-2.805	-2.822	-2.838	-2.855	-2.872	-2.889	-2.906	-2.923	-110
-100	-2.581	-2.598	-2.616	-2.633	-2.650	-2.667	-2.685	-2.702	-2.719	-2.736	-2.753	-100
-90	-2.405	-2.422	-2.440	-2.458	-2.475	-2.493	-2.511	-2.528	-2.546	-2.563	-2.581	-90
-80	-2.225	-2.243	-2.261	-2.279	-2.297	-2.315	-2.333	-2.351	-2.369	-2.387	-2.405	-80
-70	-2.042	-2.061	-2.079	-2.098	-2.116	-2.134	-2.152	-2.171	-2.189	-2.207	-2.225	-70
-60	-1.856	-1.875	-1.894	-1.912	-1.931	-1.950	-1.968	-1.987	-2.005	-2.024	-2.042	-60
-50	-1.667	-1.686	-1.705	-1.724	-1.743	-1.762	-1.781	-1.800	-1.819	-1.838	-1.856	-50
-40	-1.475	-1.494	-1.513	-1.533	-1.552	-1.571	-1.591	-1.610	-1.629	-1.648	-1.667	-40
-30	-1.279	-1.299	-1.319	-1.338	-1.358	-1.377	-1.397	-1.416	-1.436	-1.455	-1.475	-30
-20	-1.081	-1.101	-1.121	-1.141	-1.160	-1.180	-1.200	-1.220	-1.240	-1.260	-1.279	-20
-10	-0.879	-0.899	-0.920	-0.940	-0.960	-0.980	-1.000	-1.021	-1.041	-1.061	-1.081	-10
0	-0.674	-0.695	-0.716	-0.736	-0.757	-0.777	-0.798	-0.818	-0.838	-0.859	-0.879	0

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
0	-0.674	-0.654	-0.633	-0.613	-0.592	-0.571	-0.550	-0.529	-0.509	-0.488	-0.467	0
10	-0.467	-0.446	-0.425	-0.404	-0.383	-0.362	-0.341	-0.320	-0.299	-0.277	-0.256	10
20	-0.256	-0.235	-0.214	-0.193	-0.171	-0.150	-0.129	-0.107	-0.086	-0.064	-0.043	20
30	-0.043	-0.022	0.000	0.022	0.043	0.065	0.086	0.108	0.130	0.151	0.173	30
40	0.173	0.195	0.216	0.238	0.260	0.282	0.303	0.325	0.347	0.369	0.391	40
50	0.391	0.413	0.435	0.457	0.479	0.501	0.523	0.545	0.567	0.589	0.611	50
60	0.611	0.634	0.656	0.678	0.700	0.722	0.745	0.767	0.789	0.812	0.834	60
70	0.834	0.857	0.879	0.902	0.924	0.947	0.969	0.992	1.014	1.037	1.060	70
80	1.060	1.082	1.105	1.128	1.151	1.173	1.196	1.219	1.242	1.265	1.288	80
90	1.288	1.311	1.334	1.357	1.380	1.403	1.426	1.449	1.472	1.495	1.518	90
100	1.518	1.542	1.565	1.588	1.611	1.635	1.658	1.681	1.705	1.728	1.752	100
110	1.752	1.775	1.799	1.822	1.846	1.869	1.893	1.917	1.940	1.964	1.988	110
120	1.988	2.011	2.035	2.059	2.083	2.107	2.131	2.154	2.178	2.202	2.226	120
130	2.226	2.250	2.274	2.298	2.322	2.347	2.371	2.395	2.419	2.443	2.467	130
140	2.467	2.492	2.516	2.540	2.565	2.589	2.613	2.638	2.662	2.687	2.711	140
150	2.711	2.736	2.760	2.785	2.809	2.834	2.859	2.883	2.908	2.933	2.958	150
160	2.958	2.982	3.007	3.032	3.057	3.082	3.107	3.131	3.156	3.181	3.206	160
170	3.206	3.231	3.256	3.281	3.307	3.332	3.357	3.382	3.407	3.432	3.458	170
180	3.458	3.483	3.508	3.533	3.559	3.584	3.609	3.635	3.660	3.686	3.711	180
190	3.711	3.737	3.762	3.788	3.813	3.839	3.864	3.890	3.916	3.941	3.967	190
200	3.967	3.993	4.019	4.044	4.070	4.096	4.122	4.148	4.174	4.199	4.225	200
210	4.225	4.251	4.277	4.303	4.329	4.355	4.381	4.408	4.434	4.460	4.486	210
220	4.486	4.512	4.538	4.565	4.591	4.617	4.643	4.670	4.696	4.722	4.749	220
230	4.749	4.775	4.801	4.828	4.854	4.881	4.907	4.934	4.960	4.987	5.014	230
240	5.014	5.040	5.067	5.093	5.120	5.147	5.174	5.200	5.227	5.254	5.281	240
250	5.281	5.307	5.334	5.361	5.388	5.415	5.442	5.469	5.496	5.523	5.550	250
260	5.550	5.577	5.604	5.631	5.658	5.685	5.712	5.739	5.767	5.794	5.821	260
270	5.821	5.848	5.875	5.903	5.930	5.957	5.985	6.012	6.039	6.067	6.094	270
280	6.094	6.122	6.149	6.177	6.204	6.232	6.259	6.287	6.314	6.342	6.369	280
290	6.369	6.397	6.425	6.452	6.480	6.508	6.536	6.563	6.591	6.619	6.647	290
300	6.647	6.675	6.702	6.730	6.758	6.786	6.814	6.842	6.870	6.898	6.926	300
310	6.926	6.954	6.982	7.010	7.038	7.066	7.094	7.122	7.151	7.179	7.207	310
320	7.207	7.235	7.263	7.292	7.320	7.348	7.377	7.405	7.433	7.462	7.490	320
330	7.490	7.518	7.547	7.575	7.604	7.632	7.661	7.689	7.718	7.746	7.775	330
340	7.775	7.804	7.832	7.861	7.889	7.918	7.947	7.975	8.004	8.033	8.062	340
350	8.062	8.090	8.119	8.148	8.177	8.206	8.235	8.264	8.292	8.321	8.350	350
360	8.350	8.379	8.408	8.437	8.466	8.495	8.524	8.553	8.583	8.612	8.641	360
370	8.641	8.670	8.699	8.728	8.757	8.787	8.816	8.845	8.874	8.904	8.933	370
380	8.933	8.962	8.992	9.021	9.050	9.080	9.109	9.139	9.168	9.198	9.227	380
390	9.227	9.257	9.286	9.316	9.345	9.375	9.404	9.434	9.464	9.493	9.523	390
400	9.523	9.553	9.582	9.612	9.642	9.671	9.701	9.731	9.761	9.791	9.820	400
410	9.820	9.850	9.880	9.910	9.940	9.970	10.000	10.030	10.060	10.090	10.120	410
420	10.120	10.150	10.180	10.210	10.240	10.270	10.300	10.330	10.360	10.390	10.420	420
430	10.420	10.451	10.481	10.511	10.541	10.572	10.602	10.632	10.662	10.693	10.723	430
440	10.723	10.753	10.784	10.814	10.845	10.875	10.905	10.936	10.966	10.997	11.027	440
450	11.027	11.058	11.088	11.119	11.149	11.180	11.211	11.241	11.272	11.302	11.333	450
460	11.333	11.364	11.394	11.425	11.456	11.487	11.517	11.548	11.579	11.610	11.640	460
470	11.640	11.671	11.702	11.733	11.764	11.795	11.826	11.856	11.887	11.918	11.949	470
480	11.949	11.980	12.011	12.042	12.073	12.104	12.135	12.166	12.198	12.229	12.260	480
490	12.260	12.291	12.322	12.353	12.384	12.416	12.447	12.478	12.509	12.540	12.572	490
500	12.572	12.603	12.634	12.666	12.697	12.728	12.760	12.791	12.822	12.854	12.885	500
510	12.885	12.917	12.948	12.979	13.011	13.042	13.074	13.105	13.137	13.168	13.200	510
520	13.200	13.232	13.263	13.295	13.326	13.358	13.390	13.421	13.453	13.485	13.516	520
530	13.516	13.548	13.580	13.611	13.643	13.675	13.707	13.739	13.770	13.802	13.834	530
540	13.834	13.866	13.898	13.930	13.961	13.993	14.025	14.057	14.089	14.121	14.153	540
550	14.153	14.185	14.217	14.249	14.281	14.313	14.345	14.377	14.409	14.441	14.474	550
560	14.474	14.506	14.538	14.570	14.602	14.634	14.666	14.699	14.731	14.763	14.795	560
570	14.795	14.828	14.860	14.892	14.924	14.957	14.989	15.021	15.054	15.086	15.118	570
580	15.118	15.151	15.183	15.216	15.248	15.280	15.313	15.345	15.378	15.410	15.443	580
590	15.443	15.475	15.508	15.540	15.573	15.605	15.638	15.671	15.703	15.736	15.769	590
600	15.769	15.801	15.834	15.866	15.899	15.932	15.965	15.997	16.030	16.063	16.096	600
610	16.096	16.128	16.161	16.194	16.227	16.259	16.292	16.325	16.358	16.391	16.424	610
620	16.424	16.457	16.490	16.523	16.555	16.588	16.621	16.654	16.687	16.720	16.753	620
630	16.753	16.786	16.819	16.852	16.886	16.919	16.952	16.985	17.018	17.051	17.084	630
640	17.084	17.117	17.150	17.184	17.217	17.250	17.283	17.316	17.350	17.383	17.416	640
650	17.416	17.450	17.483	17.516	17.549	17.583	17.616	17.649	17.683	17.716	17.750	650
660	17.750	17.783	17.816	17.850	17.883	17.917	17.950	17.984	18.017	18.051	18.084	660
670	18.084	18.118	18.151	18.185	18.218	18.252	18.285	18.319	18.353	18.386	18.420	670
680	18.420	18.454	18.487	18.521	18.555	18.588	18.622	18.656	18.689	18.723	18.757	680
690	18.757	18.791	18.824	18.858	18.892	18.926	18.960	18.993	19.027	19.061	19.095	690
700	19.095	19.129	19.163	19.197	19.230	19.264	19.298	19.332	19.366	19.400	19.434	700
710	19.434	19.468	19.502	19.536	19.570	19.604	19.638	19.672	19.706	19.740	19.774	710
720	19.774	19.808	19.843	19.877	19.911	19.945	19.979	20.013	20.047	20.081	20.116	720
730	20.116	20.150	20.184	20.218	20.252	20.287	20.321	20.355	20.389	20.423	20.458	730
740	20.458	20.492	20.526	20.560	20.595	20.629	20.663	20.698	20.732	20.766	20.801	740
750	20.801	20.835	20.869									750

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

* CONVERTED FROM DEGREES CIIPTS 1968).

TYPE T

NEW REFERENCE TABLES
SUPERSEDES N.B.S. CIRCULAR #561

THERMOTRON

FOR PRECISION DIGITAL SET POINTS

COPPER VS. COPPER-NICKEL
(COPPER-CONSTANTAN)

TEMPERATURE IN DEGREES F RANGE −125° TO +375°F

PERCENT OF ABSOLUTE MILLIVOLT SPAN

DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F
-120	.0070	.0057	.0042	.0028	.0014	.0000						-120
-110	.0215	.0199	.0185	.0170	.0156	.0143	.0128	.0114	.0099	.0085	.0070	-110
-100	.0360	.0346	.0331	.0316	.0302	.0288	.0272	.0258	.0243	.0229	.0215	-100
- 90	.0510	.0495	.0480	.0465	.0450	.0435	.0420	.0405	.0390	.0376	.0360	- 90
- 80	.0662	.0647	.0632	.0617	.0601	.0586	.0571	.0555	.0540	.0525	.0510	- 80
- 70	.0817	.0801	.0786	.0770	.0755	.0739	.0724	.0708	.0693	.0678	.0662	- 70
- 60	.0975	.0959	.0943	.0928	.0912	.0895	.0880	.0864	.0849	.0833	.0817	- 60
- 50	.1135	.1119	.1103	.1087	.1071	.1055	.1039	.1023	.1007	.0990	.0975	- 50
- 40	.1298	.1282	.1266	.1249	.1233	.1217	.1200	.1184	.1168	.1152	.1135	- 40
- 30	.1464	.1447	.1431	.1414	.1397	.1381	.1364	.1348	.1331	.1315	.1298	- 30
- 20	.1632	.1615	.1598	.1581	.1565	.1548	.1531	.1514	.1497	.1481	.1464	- 20
- 10	.1804	.1787	.1769	.1752	.1735	.1718	.1701	.1683	.1666	.1649	.1632	- 10
0	.1977	.1960	.1942	.1925	.1907	.1890	.1872	.1855	.1838	.1821	.1804	0
0	.1977	.1994	.2012	.2029	.2047	.2065	.2083	.2100	.2117	.2135	.2153	0
10	.2153	.2171	.2189	.2206	.2224	.2242	.2260	.2278	.2295	.2314	.2332	10
20	.2332	.2350	.2368	.2385	.2404	.2422	.2440	.2458	.2476	.2498	.2513	20
30	.2513	.2530	.2549	.2568	.2585	.2604	.2622	.2641	.2659	.2677	.2696	30
40	.2696	.2714	.2732	.2751	.2769	.2788	.2806	.2825	.2843	.2862	.2881	40
50	.2881	.2899	.2913	.2936	.2955	.2974	.2992	.3011	.3030	.3048	.3067	50
60	.3067	.3087	.3105	.3124	.3143	.3161	.3181	.3199	.3218	.3238	.3256	60
70	.3256	.3276	.3294	.3314	.3332	.3352	.3371	.3390	.3409	.3428	.3448	70
80	.3448	.3466	.3486	.3505	.3525	.3544	.3563	.3583	.3602	.3622	.3641	80
90	.3641	.3661	.3680	.3700	.3719	.3739	.3758	.3778	.3797	.3817	3836	90
100	.3836	.3857	.3876	.3896	.3915	.3935	.3955	.3974	.3995	.4014	.4035	100
110	.4035	.4054	.4074	.4094	.4114	.4134	.4154	.4175	.4194	.4214	.4235	110
120	.4235	.4254	.4275	.4295	.4315	.4336	.4356	.4375	.4396	.4416	.4437	120
130	.4437	.4457	.4477	.4498	.4518	.4539	.4559	.4580	.4600	.4621	.4641	130
140	.4641	.4662	.4682	.4703	.4724	.4744	.4765	.4786	.4806	.4827	.4848	140
150	.4848	.4869	.4889	.4911	.4931	.4952	.4973	.4994	.5015	.5036	.5057	150
160	.5057	.5078	.5099	.5120	.5141	.5162	.5184	.5204	.5225	.5246	.5268	160
170	.5268	.5289	.5310	.5331	.5353	.5374	.5396	.5417	.5438	.5459	.5481	170
180	.5481	.5502	.5524	.5545	.5567	.5588	.5609	.5631	.5653	.5675	.5696	180
190	.5696	.5718	.5739	.5761	.5782	.5804	.5825	.5848	.5870	.5891	.5913	190
200	.5913	.5935	.5957	.5978	.6000	.6022	.6044	.6066	.6088	.6110	.6132	200
210	.6132	.6154	.6176	.6198	.6220	.6242	.6264	.6287	.6309	.6331	.6353	210
220	.6353	.6375	.6397	.6420	.6442	.6464	.6486	.6509	.6531	.6553	.6576	220
230	.6576	.6598	.6620	.6643	.6665	.6688	.6710	.6733	.6755	.6778	.6801	230
240	.6801	.6823	.6846	.6868	.6891	.6913	.6936	.6958	.6981	.7004	.7027	240
250	.7027	.7049	.7072	.7095	.7118	.7141	.7164	.7186	.7209	.7232	.7255	250
260	.7255	.7278	.7301	.7324	.7347	.7370	.7393	.7415	.7439	.7462	.7485	260
270	.7485	.7508	.7531	.7554	.7577	.7600	.7624	.7647	.7670	.7694	.7716	270
280	.7716	.7740	.7763	.7787	.7810	.7833	.7856	.7880	.7903	.7927	.7950	280
290	.7950	.7973	.7997	.8020	.8044	.8067	.8091	.8114	.8138	.8162	.8185	290
300	.8185	.8209	.8232	.8256	.8279	.8303	.8327	.8351	.8374	.8398	.8422	300
310	.8422	.8446	.8469	.8493	.8517	.8541	.8564	.8588	.8613	.8636	.8660	310
320	.8660	.8684	.8708	.8732	.8756	.8780	.8804	.8828	.8852	.8876	.8900	320
330	.8900	.8924	.8949	.8972	.8997	.9021	.9045	.9069	.9094	.9117	.9142	330
340	.9142	.9166	.9190	.9215	.9239	.9263	.9288	.9311	.9336	.9361	.9385	340
350	.9385	.9409	.9434	.9458	.9483	.9507	.9532	.9557	.9580	.9605	.9629	350
360	.9629	.9654	.9679	.9703	.9728	.9752	.9777	.9802	.9827	.9852	.9876	360
370	.9876	.9901	.9925	.9950	.9975	.9999						370
DEG F	0	1	2	3	4	5	6	7	8	9	10	DEG F

*CONVERTED FROM ASA TEMP. VS. EMF TABLES (THERMOTRON 1972)

TYPE T PER ASA C96.1-1971

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FOR PRECISION DIGITAL SET POINTS

COPPER VS. COPPER-NICKEL
(COPPER-CONSTANTAN)

TYPE T

TEMPERATURE IN DEGREES C RANGE −80°C TO +190°C

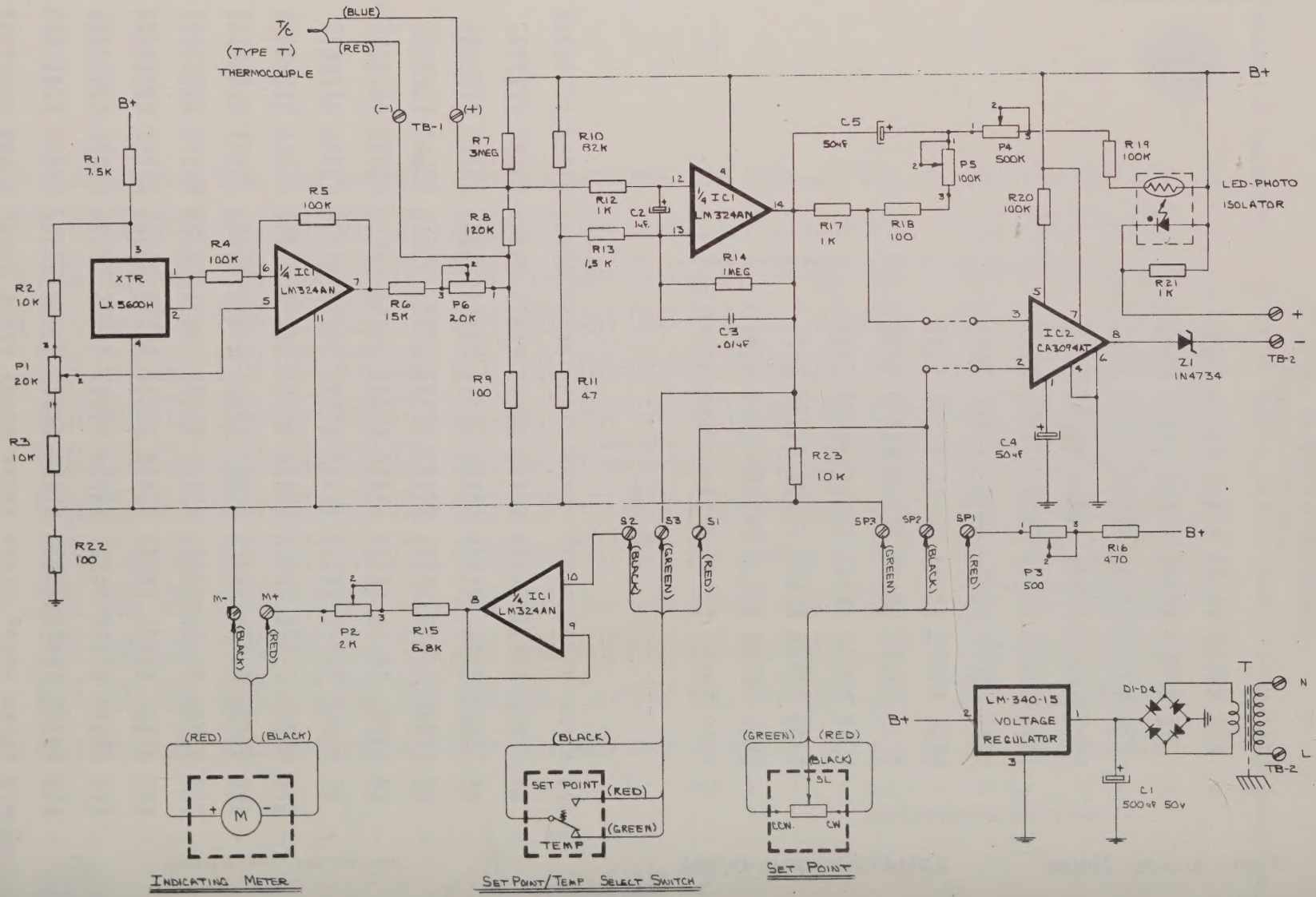
PERCENT OF ABSOLUTE MILLIVOLT SPAN

DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C
- 80	.0185	.0159	.0133	.0108	.0082	.0057	.0031	.0006				- 80
- 70	.0450	.0423	.0396	.0370	.0343	.0316	.0290	.0264	.0237	.0211	.0185	- 70
- 60	.0724	.0696	.0668	.0641	.0613	.0586	.0558	.0531	.0504	.0477	.0450	- 60
- 50	.1007	.0978	.0950	.0921	.0893	.0864	.0836	.0808	.0779	.0751	.0724	- 50
- 40	.1298	.1269	.1240	.1210	.1180	.1152	.1123	.1093	.1064	.1035	.1007	- 40
- 30	.1598	.1568	.1538	.1508	.1478	.1447	.1418	.1387	.1358	.1328	.1298	- 30
- 20	.1907	.1876	.1845	.1814	.1783	.1752	.1721	.1690	.1659	.1629	.1598	- 20
- 10	.2224	.2192	.2160	.2128	.2096	.2065	.2033	.2001	.1970	.1938	.1907	- 10
0	.2549	.2516	.2483	.2450	.2418	.2385	.2353	.2321	.2288	.2256	.2224	0
0	.2549	.2582	.2615	.2648	.2681	.2714	.2747	.2780	.2813	.2846	.2880	0
10	.2880	.2913	.2947	.2981	.3014	.3048	.3082	.3116	.3150	.3184	.3218	10
20	.3218	.3253	.3286	.3321	.3355	.3390	.3424	.3459	.3493	.3528	.3563	20
30	.3563	.3598	.3633	.3668	.3703	.3738	.3773	.3809	.3844	.3879	.3915	30
40	.3915	.3950	.3986	.4022	.4058	.4094	.4130	.4166	.4202	.4238	.4274	40
50	.4274	.4311	.4347	.4384	.4420	.4457	.4494	.4530	.4567	.4604	.4640	50
60	.4640	.4678	.4715	.4752	.4790	.4827	.4864	.4902	.4939	.4977	.5014	60
70	.5014	.5053	.5090	.5128	.5166	.5203	.5242	.5280	.5318	.5357	.5395	70
80	.5395	.5433	.5471	.5510	.5549	.5588	.5627	.5666	.5704	.5743	.5782	80
90	.5782	.5821	.5861	.5900	.5939	.5978	.6017	.6056	.6096	.6136	.6175	90
100	.6175	.6215	.6255	.6295	.6335	.6374	.6414	.6455	.6495	.6535	.6575	100
110	.6576	.6616	.6656	.6696	.6737	.6778	.6818	.6859	.6900	.6941	.6981	110
120	.6981	.7022	.7064	.7104	.7145	.7186	.7227	.7269	.7310	.7351	.7393	120
130	.7393	.7434	.7476	.7517	.7559	.7600	.7643	.7684	.7726	.7768	.7810	130
140	.7810	.7852	.7894	.7936	.7978	.8020	.8062	.8105	.8147	.8190	.8232	140
150	.8232	.8275	.8318	.8360	.8402	.8446	.8488	.8531	.8575	.8617	.8660	150
160	.8660	.8703	.8746	.8789	.8833	.8876	.8919	.8962	.9006	.9049	.9093	160
170	.9093	.9136	.9180	.9223	.9268	.9311	.9355	.9399	.9443	.9487	.9531	170
180	.9531	.9575	.9619	.9663	.9708	.9752	.9797	.9841	.9885	.9930	.9974	180
190	.9974											190
DEG C	0	1	2	3	4	5	6	7	8	9	10	DEG C

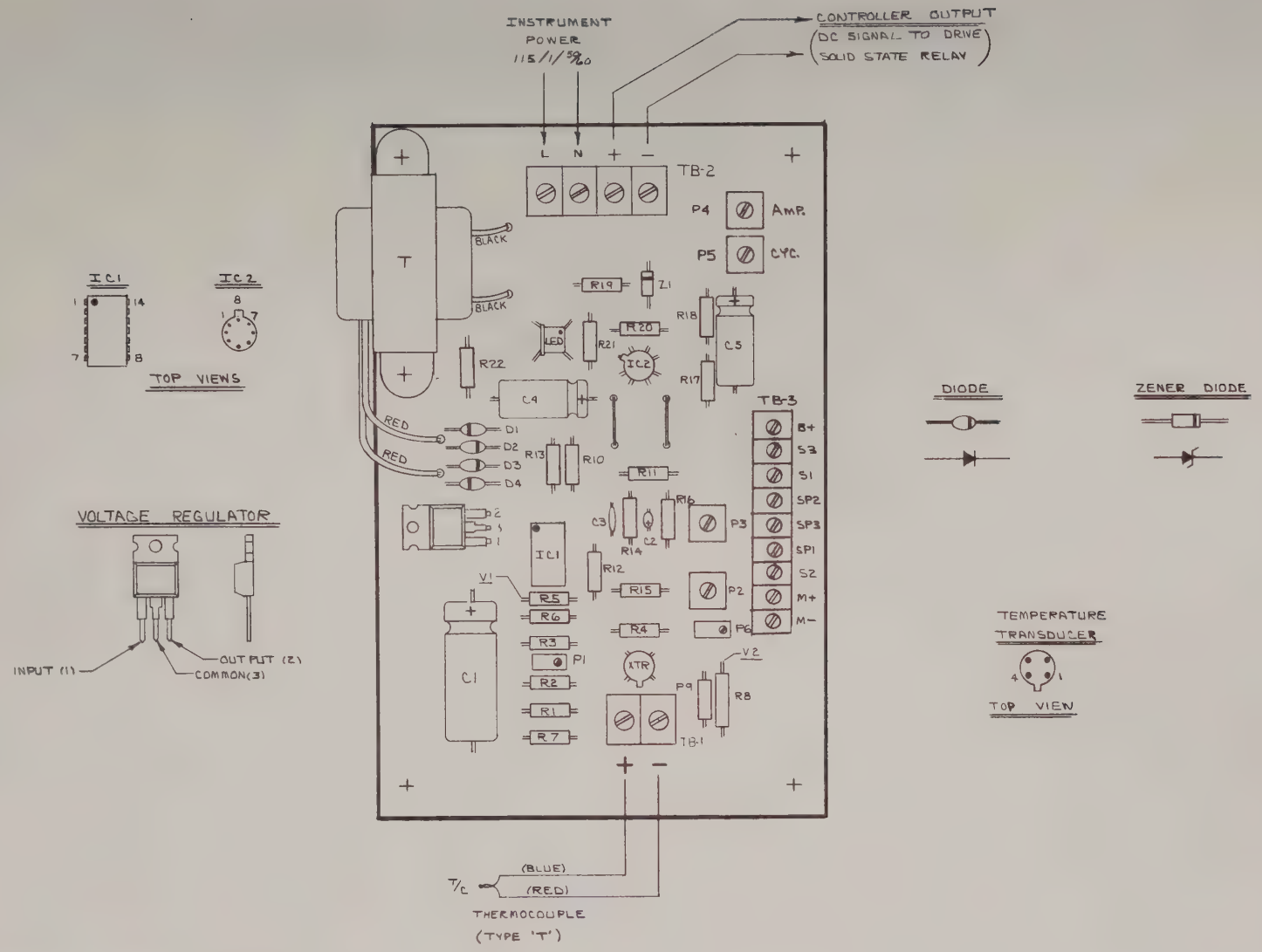
*CONVERTED FROM ASA TEMP. VS. EMF TABLES (THERMOTRON 1972)

TYPE T PER ASA C96.1-1971

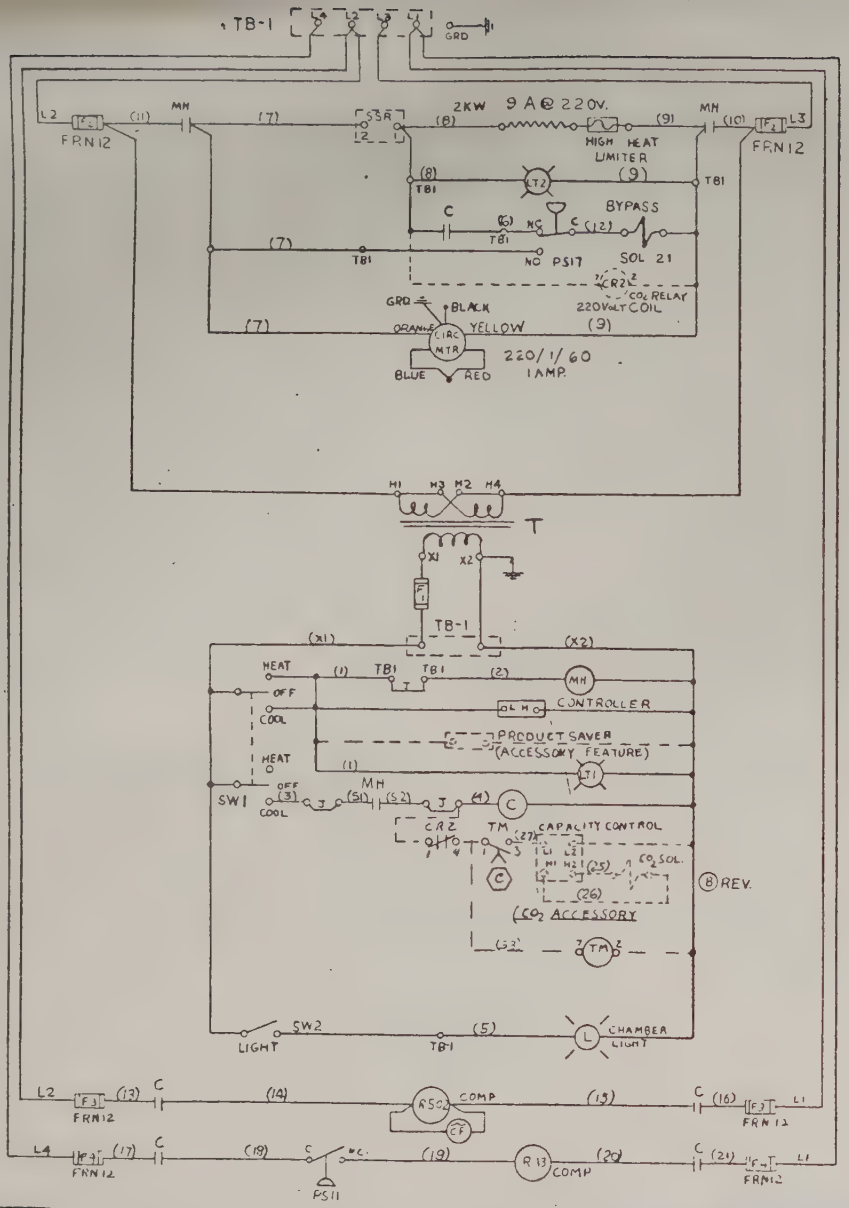
THERMOTRON

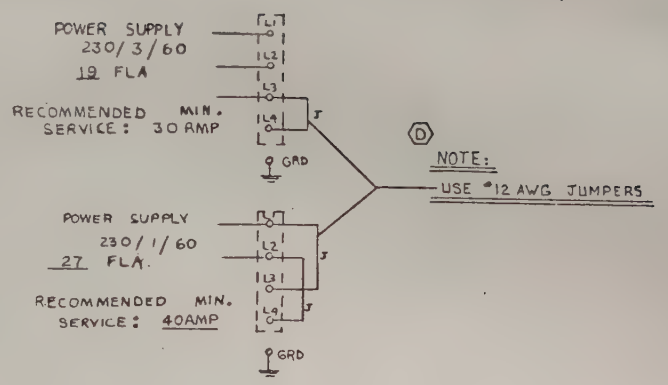


I-2053 B SCHEMATIC DIAGRAM



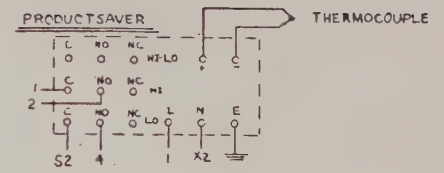
I-2053 P.C. BOARD COMPONENT LAYOUT





NOTE: HEAT LIMITER #D214-001-415°F BY 3M (A) REV.

REMOVE JUMPERS FROM CHAMBER TERMINAL BLOCK WHEN THE PRODUCTSAVER ACCESSORY IS OPTIONED



PRODUCTSAVER WIRING (ACCESSORY FEATURE)

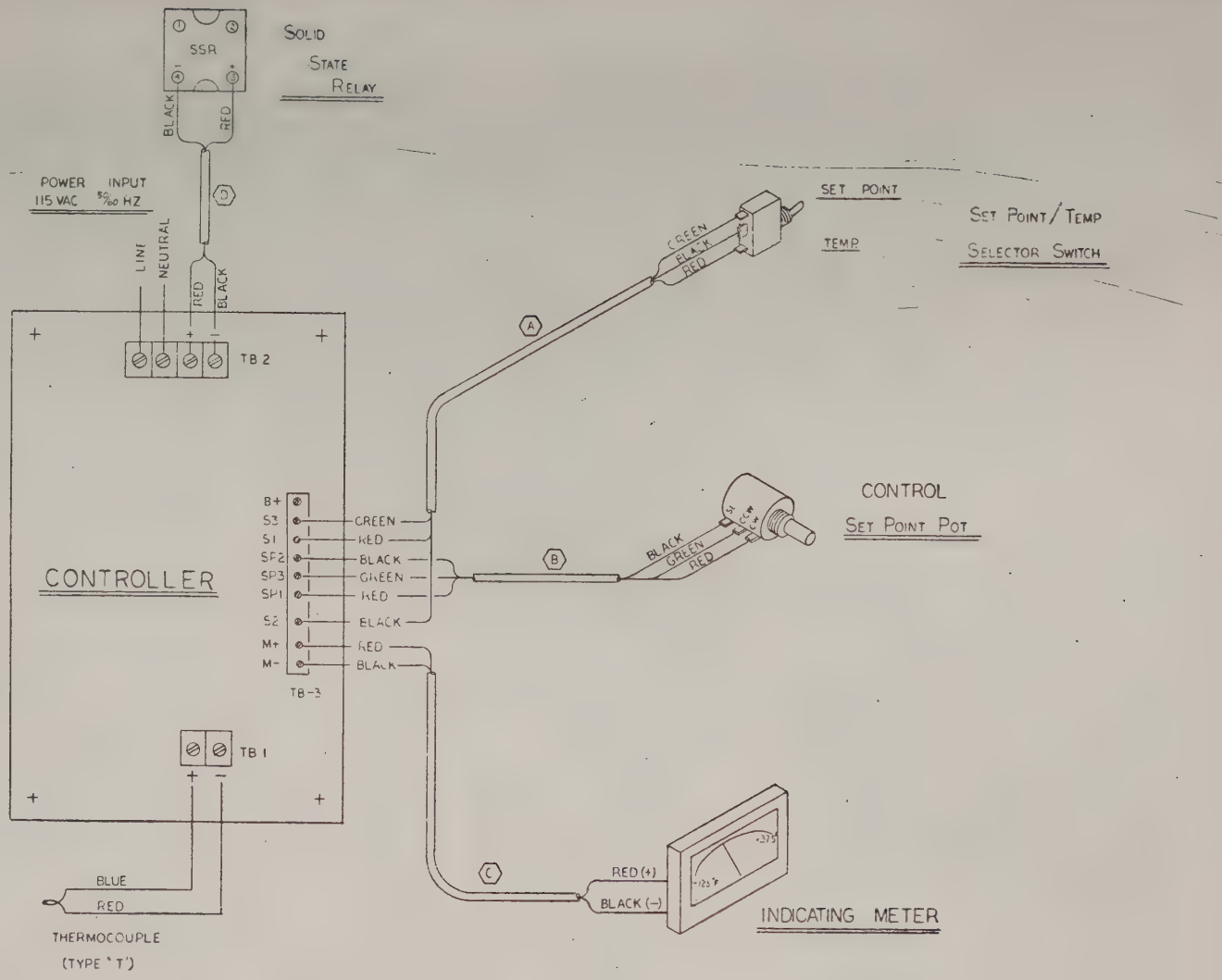
THERMOTRON CORPORATION
HOLLAND, MICHIGAN 49423

NO	CHANGES	DATE	BY	CHKD
A	ADDED [illegible]	[illegible]	[illegible]	[illegible]
B	ADDED [illegible]	[illegible]	[illegible]	[illegible]
C	USE PARTS LIST 3297 [illegible]			
D	[illegible]			
E	ADD NOTE			
F	[illegible]			

TOLERANCE
SCALE
MATERIAL SEE PARTS LIST
FINISH
DRAWN BY R HOLSEY DATE
CHECKED BY DATE
RELEASED BY DATE

DESCRIPTION
S-4 & S-8 STANDARD
ELECTRICAL SCHEMATIC

DRAWING NO E-5249-13 SIZE X



CABLE	PART No.	LENGTH
A	P3W□2-5	
B	P3W□2-5	
C	P3W□2-4	
D	P3W□2-4	

THERMOTRON CORPORATION
HOLLAND, MICHIGAN 49423

NO	CHANGES	DATE	BY	CHK'D
A	INQUIRY CAT NUMBER MINI XTP			
B	ADDED SHIELD PLY PAD WIRE ADDED PLY PAD			

NO	CHANGES	DATE	BY	CHK'D

TOLERANCE
SCALE
MATERIAL
FINISH
DRAWN BY PDK DATE 4-14-78
CHECKED BY DATE
APPROVED BY DATE

DESCRIPTION
CONROL SYSTEM
WIRING INFORMATION

DRAWING NO I 2053B-3
SIZE X

PROTECTIVE OR SAFETY DEVICES

The following are the protective or safety devices used in the refrigeration and electrical circuits (besides the branch circuit protection). Refer to electrical and refrigeration schematics.

RELIEF VALVE: (S-4 and S-8 Series)

Located in the low pressure piping of the R-13 system to protect the system against excessive pressure. The valve is designed to relieve at 150 PSI.

RELIEF VALVES: (S-16 and S-32 Series)

One is located in the high pressure piping of the R-13 system; one is located in the high pressure piping of the R-502 system; and one is located in the low pressure piping of the R-13 system, to protect the systems against excessive pressure. The valves in the high pressure piping are factory-designed to relieve at 400 PSI and the valve in the low pressure piping is designed to relieve at 150 PSI.

PRESSURE SWITCHES:

One in each refrigeration system: R-13 primary cooling system and R-502 secondary cooling system. The R-13 switch is piped to sense the pressure of the discharge side of the refrigeration compressor, set to interrupt the control circuit of the compressor at abnormal pressure (cut in at 250#; cut out at 235#). The R-502 switch is piped to sense the pressure of the suction side of the R-502 compressor to momentarily delay starting of the R-13 compressor. (Cut in at 25#; cut out at 35#.) The switches are automatically reset. (Factory set and adjustable.)

PROTECTIVE OR SAFETY DEVICES

HI-HEAT LINK: (Electrical Schematic)
Is wired in series with the heater to open the circuit to protect the chamber from exceeding designed temperature limits. This control will open when the chamber temperature reaches approximately 400°F. (Not resettable; replace.)

INHERENT OVERLOAD PROTECTION:
Located in each refrigeration compressor motor. These are factory designed to open the motor circuit within safe limits. (Non-adjustable; automatic reset.)

INTERLOCK:
The circuit motor is interlocked with the heat control circuit to protect the heaters.

A GUARD is provided for the circulator fan.

REFRIGERANTS used are non-toxic.

ALL ELECTRICAL CIRCUITS are separately fused.

ALL MACHINERY is enclosed.

OPERATING PROCEDURES

To simulate temperatures above +120°F, perform the following procedures:

1. Place the HEAT/COOL switch in the HEAT position.
2. Hold the SET POINT/TEMPERATURE switch in the SET POINT position and adjust the TEMPERATURE control until the pointer in the indicating meter points to the desired operating temperature.
3. Release the SET POINT/TEMPERATURE switch. The indicating meter will now monitor the chamber temperature.

To simulate temperatures below +120°F, perform the following procedures:

1. Place the HEAT/COOL switch in the COOL position.
2. Hold the SET POINT/TEMPERATURE switch in the SET POINT position and adjust the TEMPERATURE control until the pointer in the indicating meter points to the desired operating temperature.
3. Release the SET POINT/TEMPERATURE switch. The indicating meter will now monitor the chamber temperature.

MAINTENANCE

TROUBLESHOOTING GUIDE

	Symptoms		Cause		Remedy
A.	Compressor does not run.	1.	Main power disengaged.	1.	Close main power disconnect or equipment disconnect switch.
		2.	Fuse blown.	2.	Replace fuse.
		3.	Compressor seized.	3.	If the compressor has caused the inherent overloads to trip, allow time for the compressor to cool and the inherent overloads to reset. Restart the compressor. If the compressor will not start, notify the factory for further assistance.
		4.	Compressor control circuit open.	4.	Check for open control circuit.
B.	Compressor will not start; hums intermittently. (cycling on overload.)	1.	Improperly wired.	1.	Check wiring against diagram.
		2.	Low line voltage.	2.	Check main line voltage; determine location of voltage drop.
		3.	Open starting capacitor.	3.	Replace starting capacitor.
		4.	Open circuits in starting winding	4.	Make a continuity chk of the starting winding.
		5.	Stator winding grounded.	5.	Make a continuity check from the stator winding to ground.
		6.	High discharge pressure.	6.	Check for refrigeration overcharge or non-condensables.

	Symptoms		Cause		Remedy
C.	Compressor starts, motor will not get off starting winding.	1.	Low line voltage.	1.	Bring up voltage.
		2.	Improperly wired.	2.	Check wiring against diagram.
		3.	Defective start-run relay.	3.	Check operation manually; replace relay if defective.
		4.	Running capacitor.	4.	Check by disconnecting running capacitor.
		5.	Starting and running windings shorted.	5.	Check resistances. replace stator if defective.
		6.	Starting and running windings shorted.	6.	Check capacitance; replace if low.
		7.	High discharge pressure.	7.	Check for refrigerant overcharge or non-condensables.
D.	Start-run relay burnout.	1.	Low line voltage.	1.	Increase voltage to not less than 10% under compressor motor rating.
		2.	Excessive line voltage.	2.	Reduce voltage to maximum of 10% over motor rating.
		3.	Incorrect running capacitor.	3.	Replace running capacitor with correct mfd. capacitance.
		4.	Short cycling.	4.	Reduce number starts per hour. (See Sect.B)
		5.	Incorrect mounting.	5.	Mount relay in correct position.
		6.	Incorrect relay.	6.	Use relay properly selected for motor characteristics.
		7.	Relay vibrating.	7.	Mount relay in rigid location.

Symptoms	Cause	Remedy
E. Insufficient cooling effect.	1. Refrigerant shortage.	1. Repair leak and recharge.
	2. Frosted coil.	2. Defrost and dry coil.
	3. Air-cooled condenser obstructed.	3. Clear obstruction.
	4. Compressor inefficient.	4. Check for defective valves.
	5. Capillary tube obstructed.	5. Remove obstruction.
	6. Heat generating load is too great.	6. Consult factory for assistance.
F. R-13 head pressure too high.	1. Refrigerant overcharge.	1. Relieve some gas from system.
	2. Non-condensables in system.	2. Evacuate to recharge.
	3. R-502 system short of gas.	3. Repair leak and re-charge.
	4. Bypass solenoid not opening.	4. Replace.
	5. R-13 pressure switch PS11 defective.	5. Replace.
G. R-13 head pressure too low.	1. Refrigerant shortage.	1. Repair leak and re-charge.
	2. Compressor inefficient.	2. Replace.
	3. Bypass solenoid not closing.	3. Replace.

	Symptoms		Cause		Remedy
H.	R-502 head pressure too high.	1.	Condensing air too warm.	1.	Supply cooling air.
		2.	Restricted air-cooled condenser.	2.	Clean condenser.
		3.	Non-condensables in system.	3.	Evacuate and re-charge.
I.	R-502 head pressure too low.	1.	Condensing air too cold.	1.	Heat air.
J.	Noisy unit.	1.	Tubing rattle.	1.	Bend tubes away from contact.
		2.	Mountings loose.	2.	Tighten.
		3.	R-13 pressure switch PS11 defective.	3.	Replace.
		4.	Refrigerant flooding back.	4.	Consult factory for assistance.
K.	Compressor loses oil.	1.	Shortage of refrigerant.	1.	Repair leak and recharge.
		2.	Short cycling.	2.	Refer to Section B.
L.	Chamber will not control at ambient.	1.	Instrument misadjusted.	1.	Recalibrate
		2.	Defective thermocouple.	2.	Replace.
		3.	Low voltage.	3.	Consult factory for assistance.